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# Longrun Supply and Demand of New Residential Construction in the United States: 1986 to 2040

Claire Montgomery

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## Abstract

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A model of U.S. housing demand and supply was developed that projects housing starts for use in long-term forest planning. Housing demand was shown to respond to the current sale price and the user capital cost of housing and to the size and age composition of the population. Current sale price is determined in the new construction market. Supply of new construction was modeled and was shown to have a supply price elasticity of zero. The choice of housing type was shown to respond to the age of the householder and, in some age classes, to the price of housing services. Two projections of housing starts by housing type from 1987 to 2040 were produced; they differ in the assumed rate of discards from the existing housing stock.

**Keywords:** Housing markets, housing demand, new residential construction.

## Summary

A model of U.S. housing demand and supply was developed that projects housing starts for use in long-term forest planning. A headship rate equation was estimated, which relates the fraction of the population heading a household, by age class, to the current sale price of housing, the lagged rental price of housing, and a time trend. Because permanent income and the time trend are multicollinear, the coefficient on the time trend represents the combined effect on headship rate of income and trends in social customs. An inverse supply equation for new construction was estimated, relating the price of housing to factor prices and the number of housing starts. Because the coefficient for housing starts was not significantly different from zero, the supply price elasticity was assumed to be zero, and housing starts were dropped from the equation. This eliminates simultaneity between supply and demand for new construction. Equations were estimated for two age classes to relate the proportion of householders in that age class selecting single-family dwellings to the lagged rental price of housing.

Two projections of housing starts by housing type from 1987 to 2040 were produced; they differ in the assumed rate of discards from the existing housing stock. Projections of underlying macroeconomic variables were exogenous. These projections show variation in the first two decades but little variation thereafter. As a result, housing start projections are responsive to economic signals initially but are driven primarily by demographic trends after 2007.

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## Introduction

Demand for solid wood products is derived from the production of wood-using goods for purchase by consumers. The largest share of this demand is in residential construction, which accounted for about 37 percent of lumber and 45 percent of structural panels consumed in 1986.<sup>1</sup> A projection must be made of the future level of residential construction to assess future demand for timber. This paper reports a model of demand and supply for housing in the United States that produces projections of housing starts for single- and multiple-family housing units and for mobile homes for use in long-term forest planning.

Attempts to make long-term projections of housing starts are often based only on the demographics of the total population and trend forecasts of household formation rates (see footnote 1). An implied assumption is that the housing supply will expand to meet demand. Marcin (1978) and Ueda and Darr (1980) make more sophisticated use of available demographic data. They represent population by age class, which recognizes that the rate of household formation varies with age. This approach allows models to incorporate the effect on housing demand of the changing composition of the population. Marcin also recognizes that housing is a commodity (goods), and individuals choose to consume goods in response to economic variables. He estimates separate equations for headship rate (the fraction of the population heading a household) by age class with personal disposable income as an explanatory variable.

A complete economic explanation of household formation is needed to fully assess the impact of changes in macroeconomic policy variables, such as interest rates, on the housing sector, and subsequently on the forest products market. Theoretically, household formation depends on income, the user cost of capital for housing, the relative price of housing, and the age composition of the population. For statistical methods to provide insights to the theoretical relations among economic variables, movement must occur in the observed variables relative to one another. From 1950 to the early 1970's, headship rates increased with little variability. Income grew continuously, while real interest rates, the primary component of the user cost of capital for housing, were relatively constant. As a result, most efforts to predict headship rates in that period were based on trend forecasts; the multicollinear behavior of time and income made it impossible to disentangle their separate effects. But in the past two decades, increased volatility in economic variables have presented economists with new opportunities to explore relations among economic variables. Headship rates, in particular, have fluctuated considerably, as have interest rates and inflation. This increased volatility allowed me to explore the theoretical relations among the household formations component of housing demand and income, relative price of housing, and user cost of capital for housing.

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<sup>1</sup> Haynes, Richard W. 1987. Housing projections for the southern supply study. Data on file with: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

Because housing prices are determined by the equilibrium between supply of and demand for new construction, the model must explain supply. The resulting projections of housing starts respond to demand determinants such as mortgage rates, income, property tax rates, marginal income tax rates, expected rate of capital gain on housing, price of new construction, price of all other goods, and the expected rate of inflation; they also respond to supply determinants such as wood, labor and financing costs, and land prices. The choice among housing types (single-family dwelling, multiple-family dwelling, or mobile home) is modeled as a function of age of householder and the price of housing services.

## The Model

The demand for new residential construction, or housing starts ( $s_j$ ), of type  $j$  is made up of three components: change in the demand for housing stock ( $l_{j,t} - l_{j,t-1}$ ), replacement of discarded units ( $d_j$ ), and so-called unspecified additions to stock ( $k_j$ ):

$$s_{j,t} = (l_{j,t} - l_{j,t-1}) + d_{j,t} - k_{j,t} . \quad (1)$$

Unspecified additions to stock include conversions of buildings from nonresidential to residential use and conversions from buildings with few housing units to buildings with many housing units.

Because some vacant units always exist, the housing stock is greater than the number of households ( $H_j$ ) occupying it:

$$l_{j,t} = H_{j,t} / o_{j,t} , \quad (2)$$

where  $o_{j,t}$  is the occupancy rate for housing type  $j$ . Occupancy rates, derived from data published in U.S. Department of Commerce, Bureau of the Census, annual housing survey, are higher for single- than for multiple-family dwellings with averages of 92 percent and 87.5 percent, respectively, from 1973 through 1983. Occupancy rates are less than 100 percent partly because of seasonally used second homes and partly because of the partial adjustment of the housing stock to its desired equilibrium level. The portion resulting from partial adjustment should vary directly with the amount of volatility in the determinants of demand for and supply of housing. Because occupancy rates varied little during the sample period according to data reported in the annual housing survey, average values are used in this model.

The total number of households ( $H$ ) is computed as follows:

$$H_t = \sum_{a=1}^A h(r_t, r_{t-1}, p_t, p_{t-1}, y_t, t, a) * N_{a,t} , \quad (3)$$

where

$h(\cdot)$  is the headship rate,  
 $a$  is the age class numbered from 1 to  $A$ ,  
 $r_t$  is the rental price of housing,  
 $p_t$  is the sale price of the representative house,  
 $y_t$  is permanent income, and  
 $N_{a,t}$  is population in age class  $a$ , all at time  $t$ .

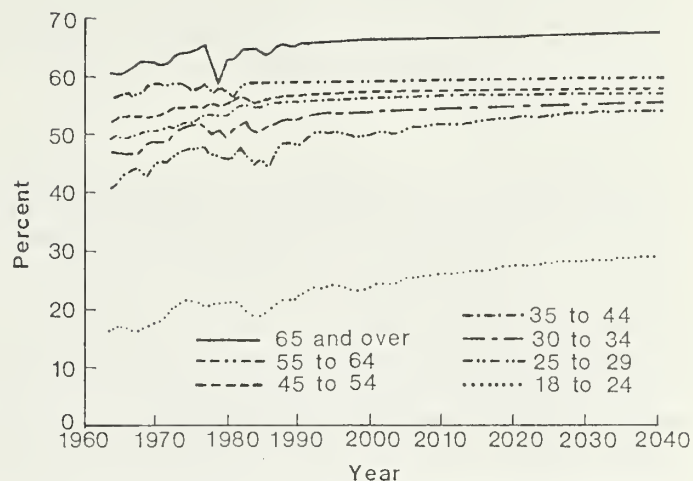


Figure 1—Headship rates by age class.

The choice to form new or to maintain existing households is one means by which individuals express their demand for housing. They respond to economic variables, given their own preferences. In this model, the observed sample proportion of the population heading a household, or the headship rate, represents that choice.

The life cycle theory of consumption (Ando and Modigliani 1963) states that individuals want to smooth consumption over their lifetime even though income may not come evenly. In fact, most people have an increasing income path into middle age; income levels off during prime earning years and drops abruptly at retirement. The desire for even consumption dictates a lifetime savings pattern that is negative in early years as people try to borrow against future earnings, is positive during prime earning years as people accumulate wealth, and is negative after retirement as they transform this wealth back into consumption. Housing is a form of wealth, so the desire to hold housing should increase with age through the prime earning years.

Demographic factors and social customs also influence the relation between headship rate and the age ( $a$ ) of the householder. It is customary to form independent households, usually consisting of two adults, during early adulthood and to maintain those households during middle age. In old age, mortality increases the incidence of single-adult households, so headship rates are higher in old age than in middle age. Figure 1 shows headship rates by age class.

Social and demographic patterns change over time. Decreasing trends in marriage rates and increasing trends in divorce rates and in the mobility of the labor force correspond to increasing headship rates. Although behavioral trends probably have their own economic explanations, I made no attempt to uncover them in this study. These changes are represented by the time trend variable ( $t$ ).

A unit of housing stock is a capital asset providing a flow of housing services throughout its life. The rental price of housing ( $r$ ) is the price of housing services. The cost is equivalent to buying a house, living in it for 1 year, and selling it at the end of the year; it does not include transaction costs such as loan fees, broker fees, and search and moving costs.

The real sale price of a constant-quality house ( $p$ ) is in the equation for headship rate. To buy a home on a mortgage, a down payment proportional to the sale price of the home is required. Potential home owners prevented from borrowing as much as they want against future earnings at market interest rates must postpone consumption to save the down payment. First-time buyers are the group most likely to find themselves in this situation. The sale price is also the amount of cash received when the asset is liquidated. Householders at or beyond retirement who are in the process of converting assets to consumption would be less likely to hold a house and maintain a separate household when the price is high than when it is low. Sale price should matter to both the oldest and the youngest age groups.

Rental and sale prices of housing do not move together. They moved very differently from one another during the sample period, 1963 to 1985 (figs. 2 and 3). They are related to one another as follows:

$$r_t = p_t * [(Z_t + \tau_t) * (1 - i_t) - \pi^e_t + d_t - g^e_t], \quad (4)$$

where

$Z_t$  is nominal mortgage rate,  
 $\tau_t$  is property tax rate,  
 $i_t$  is marginal income tax rate,  
 $\pi^e_t$  is expected rate of inflation,  
 $d_t$  is gross depreciation rate, and  
 $g^e_t$  is expected rate of capital gain on housing, all at time  $t$ .

The term in brackets is the user cost of capital for housing (Hendershott 1980), the first part of which,

$$(Z_t + \tau_t) * (1 - i_t) - \pi^e_t,$$

is the tax-adjusted real rate of interest faced by the householder.

The choice of tenure (to rent or to buy) was not addressed directly in this study. Many households choose to rent rather than own housing. If housing markets were perfectly efficient, then on the margin, the annual rent for a house on the rental market (the price of rental housing), would be the same as the rental price of housing for an equivalent house. Any factor affecting the rental price of housing would also affect the price of rental housing. The housing market does not adjust immediately to price signals for a variety of reasons: uncertainty about the value of economic variables, such as inflation and capital gains, liquidity constraints, and transaction costs. It takes time for homeowners to respond to changes in economic variables and for those changes to be reflected in rental markets. For this reason, lagged values of both rental and sale price are included in the equation for headship rates.



Figure 2—Rental price of housing.

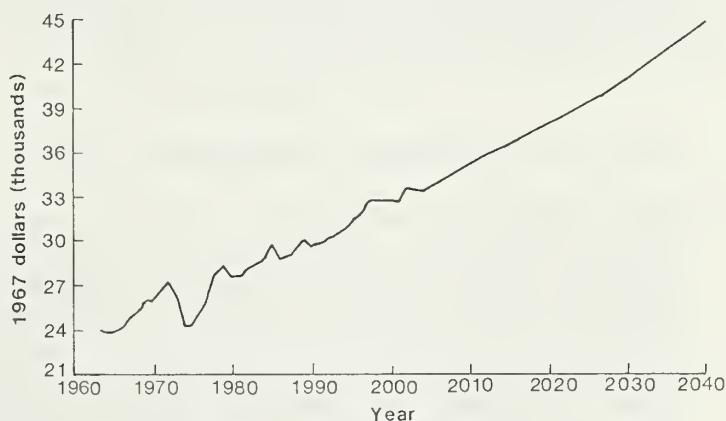


Figure 3—Real sale price of constant quality house.

The sale price of housing units is determined by the equilibrium of supply and demand for new construction. If supply of new construction is perfectly elastic, as is indicated by Follain (1979), then price is the supply price, equal to the average cost of construction, and is not determined jointly with the quantity of output. This is often true in industries characterized by many firms of similar size having low capital requirements, such as the residential construction industry. The general inverse supply equation is:

$$p_t = p(s_t, v_t), \quad (5)$$

where  $v_t$  is a vector of prices of inputs—wood, labor, land, financing and miscellaneous materials—and  $s_t$  is the total number of housing starts. If supply is perfectly elastic, then the supply price elasticity,  $[(dp/ds) \cdot (s/p)]^{-1}$ , is zero. This can be true only if the coefficient for  $s_t$  is zero. The inverse supply equation then becomes:

$$p_t = p(v_t), \quad (5a)$$

and price is determined solely by input prices.

As housing is a normal good, people will want more of it when their income ( $y$ ) increases. Their housing choice depends on the amount of income they perceive as permanent—something they expect to continue to receive in the future. The definition of permanent income is the fixed amount of a person's wealth, including future earnings, that one could consume this year and every year in perpetuity without running out. People base their estimate of permanent income on expected future earnings. This expectation is influenced by the current and past level of income, educational status, and stage of life. Because permanent income cannot be observed, I use an average of income for the current and past 2 years as a proxy.

Once the choice to maintain a household has been made, the individual must choose a housing type. I modeled the choice among single- and multiple-family structures and mobile homes. Age plays a role in this choice. Young people tend to choose multiple- rather than single-family dwellings. The proportion of households choosing single-family dwellings increases throughout the prime earning years and then drops off as people pass 65 years of age. The movement from multiple- to single-family dwellings is influenced by the rental price of housing so that the number of households in each housing type is:

$$H_{j,t} = w_j(r_{t-1}) * H_t, \quad (6)$$

where  $w_j(r_{t-1})$  is the fraction choosing type  $j$ .

The level of housing stock is altered in three ways: units are discarded, units are added by conversion of existing structures, and units are added by new construction. Discard rates should, on average, equal the net depreciation rate. Estimates of net depreciation rates, which are exclusive of unintentional loss through disaster, range from 0.39 to 0.7 percent (Margolis 1982), so the expected half life of a geometrically depreciating house is 100-200 years. The discard rate, which includes disaster loss, seems to be volatile in the short run and to average 0.6 percent per year (table 1). The level of unspecified additions to stock is also volatile. I used outside sources and trend forecasts for projections of discard rates and unspecified additions to stock.

**Table 1—Removals, by census year, as a percentage of structures in an age class<sup>a</sup>**

Census year	Age of structure	Structures removed per year
	<i>Years</i>	<i>Percent</i>
1960	10 to 20	0.57
	Over 20	.69
1970	10 to 20	.61
	20 to 30	.92
	Over 30	1.32

*See footnote on next page.*

**Table 1—Removals, by census year, as a percentage of structures in an age class<sup>a</sup>**  
(continued)

Census year	Age of structure	Structures removed per year
	<i>Years</i>	<i>Percent</i>
1980	10 to 20	0.48
	20 to 30	.29
	30 to 40	.52
	Over 40	.92

<sup>a</sup> The census year indicates the decade ending with that year.

## Estimation

The estimated equations are inverse supply (equation 5), headship rate in equation (3), and fraction choosing type of unit by age class (equation 6). Lists, sources, and construction of historical data series are in appendix 1. Data are annual observations from 1963 through 1985.

Results for equation (5), estimated as:

$$p_t = C_0 + C_1 \cdot S_t + C_2 \cdot VW_t + C_3 \cdot V_l_t + C_4 \cdot VS_t + C_5 \cdot r_t ,$$

where

$S_t$  is the number of housing starts,  
 $VW_t$  is real wood cost index,  
 $V_l_t$  is real carpenters' wage index,  
 $VS_t$  is real price of equivalent site, and  
 $r_t$  is real rate of interest, all at time  $t$ ,

are in table 2. The equation is estimated by using two-stage least squares because of the potential endogeneity of housing starts. Instruments are permanent income, total population over 18, and user cost of capital for housing. The coefficient for housing starts is not significantly different from zero at the 5-percent significance level. This implies that the price elasticity is zero. Thus, equations for supply and headship rates are not simultaneous and can be estimated separately with ordinary least squares. The signs on cost coefficients are positive as expected, except for the real carpenter wage index. Follain estimated an inverse supply function for new construction and obtained comparable results for the supply elasticity and the signs on the cost coefficients. Coefficients for housing starts and for real carpenter wage index are dropped. Serial correlation in the disturbance term is detected (Durbin-Watson statistic is 1.04), and the final equation is estimated with a correction for autocorrelation of order one.

**Table 2—Inverse supply equation<sup>a</sup>**

Coefficient	Full equation	Final equation
constant	7980 (7.14)	9868 (6.33)
S <sub>t</sub>	-4.49 (0.82)	— —
vw <sub>t</sub>	66.95 (6.76)	49.04 (6.15)
vl <sub>t</sub>	-24.53 (2.02)	— —
vs <sub>t</sub>	3.28 (10.20)	2.60 (6.88)
ri <sub>t</sub>	45399 (7.14)	38714 (5.37)
rho	— —	0.5536 (3.19)
R <sup>2</sup> adj =	0.944	0.946
DW =	2.00	2.25

<sup>a</sup> t-statistic is given in parentheses.

Equation (3) is estimated as a logit model because headship rate is the sample probability of an individual forming a household. The derivation of the form of the estimated equation and statistical methods are described in appendix 2. Results are in table 3. Hypothesis testing shows that the coefficients for time are not significantly different by age class and that the coefficients for current rental price and lagged sale price are not significantly different from zero at the 1-percent significance level. Coefficients for income are also jointly not different from zero at the 1-percent significance level. This is probably due to multicollinearity, which makes it impossible to determine separate effects of time and income. Finally, the coefficients for lagged rental price in the 35-44 and 55-64 age classes are not significantly different from zero and are positive. The final equation includes a single coefficient for time and separate coefficients for current sale price in all age classes and for lagged rental price in all but the 35-44 and the 55-64 age classes. In the final equation, the coefficients for sale price are most significant for the youngest and the oldest age classes, as expected. The coefficients for rental price are most significant for the youngest age classes. In those age classes, people purchase housing stock primarily for the housing services that it provides. The coefficient for time is highly significant in the final equation because it represents the combined effect of income and time on headship rate. If the structural relation between income and time is expected to continue over the prediction period, it is acceptable to include only one of the two variables in the estimated equation.

**Table 3—Coefficient estimates for headship rates<sup>a</sup>**

Age class	Coefficient			
	Constant	Rental price	Sale price	Time <sup>b</sup>
18-24	2.462 (4.47)	-0.000277 (5.96)	-0.000126 (5.23)	0.0783 (9.87)
25-29	4.131 (8.46)	-.000204 (5.53)	-.000158 (7.11)	.0783 (9.87)
30-34	3.195 (5.54)	-.000139 (2.80)	-.000105 (4.22)	.0783 (9.87)
35-44	1.159 (2.27)	— —	-.0000215 (0.91)	.0783 (9.87)
45-54	2.646 (4.39)	-.0000769 (1.29)	-.0000631 (2.44)	.0783 (9.87)
55-64	5.142 (8.01)	— —	-.000138 (5.13)	.0783 (9.87)
65 and over	4.423 (8.68)	-.0000209 (0.50)	-.000137 (5.98)	.0783 (9.87)
R <sup>2</sup> adj = 0.936				

<sup>a</sup> t-statistic is given in parentheses.

<sup>b</sup> t<sub>0</sub> = 13.

Five observations are available for the proportion of households by age class choosing each of the three types of housing units. The proportion choosing mobile homes is stable over time in all age groups. Only two age groups, 30-34 and 35-44, show much variability in the choice between single- and multiple-family dwellings. At these ages, people are entering their prime earning years, and they begin to accumulate assets and consider homeownership—typically ownership of single-family dwellings. Because of the limited number and the small range of the data observations, I used a simple linear model rather than a probability model to link the proportion of people choosing single-family residences to the rental price of housing:

$$w_{j,t} = d_0 + d_1 * r_{t-1} .$$

Estimation results are given in table 4.

**Table 4—Fraction of households, by age class, choosing single-family dwellings<sup>a</sup>**

Coefficient	Age class (years)	
	30-34	35-44
Constant	0.6945 (63.17)	0.7803 (186.5)
Rental price	-.0000206 (2.21)	-.0000136 (3.83)
R <sup>2</sup> adj =	0.49	0.77

<sup>a</sup> t-statistic is given in parentheses.

## Projections

Several variables that enter the model exogenously are projected independently. All projections are listed and the projection methods are explained in appendix 3.

Two projections are made of the level of housing starts by housing type from 1986 to 2040. They differ in assumptions about future discard rates. If the housing stock is mature (that is, if it is evenly distributed over the age of structure, and the average age is about equal to the expected life of a house), the discard rate should be constant over time. If, however, the distribution of housing stock over age of structure is skewed toward newly built structures, discard rates should increase as the housing stock matures.<sup>2</sup> The first projection assumes gradually increasing discard rates after 2007 and is appropriate for a country as young as the United States. The second projection assumes constant discard rates after 2007 (fig. 4).

<sup>2</sup> Data published by the U.S. Department of Commerce, Bureau of the Census (1960, 1970, and 1980) describing the number of dwellings in the housing stock by the year that the structure was built are not sufficient to establish a clear pattern of the retirement of housing from the housing stock. In fact, the number of dwellings actually increases over time for several vintages of housing. This could be due to unspecified additions to the stock or could be a vestige of the survey methodology. Data describing removals as a percentage of the housing stock by age of dwelling (table 1) also fail to provide a complete enough picture to draw conclusions from. Removal rates vary widely; not enough observations have been made over a long enough history to discern a pattern.

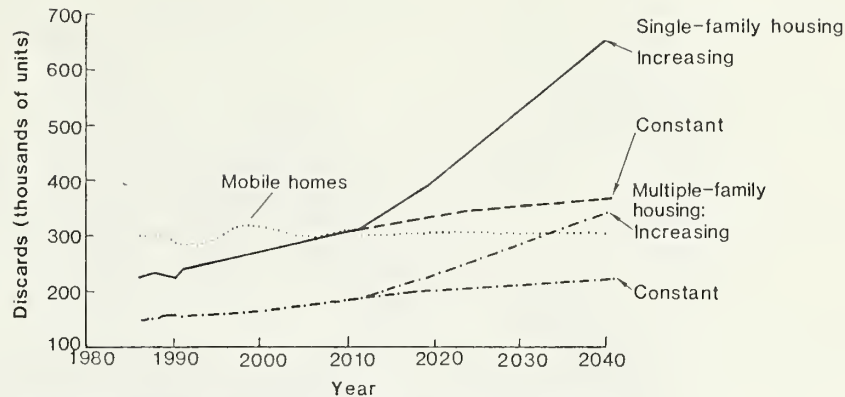


Figure 4—Quantities discarded with increasing and constant discard rates.

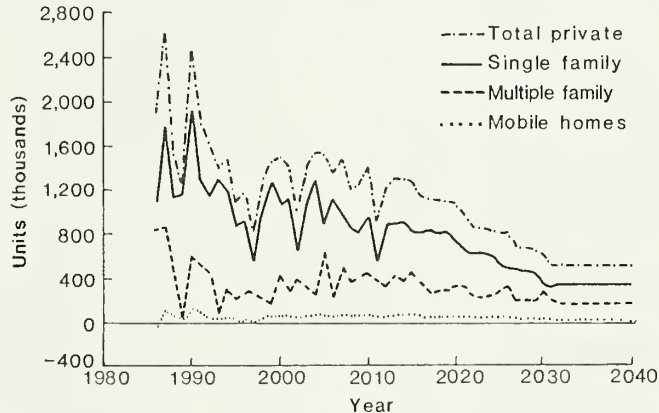


Figure 5—Change in demand for housing stock.

The change in demand for housing stock ( $I_t - I_{t-1}$ ) depends positively on changes in headship rate and in population. Projections are reported in figure 5. The general level and trend is explained primarily by demographics. High levels in the late 1980's result from movement of a large number of 18-25 year olds into the 25-29 and 30-34 age groups in which headship rates are higher (fig. 6). The trend after that period is generally downward as the number of people moving through the young age classes decreases. A bulge early in the 21st century can be attributed to a new group of 18-25 year olds (the so-called baby boom echo) forming households and moving into older age classes. Fluctuations around the general trend result from changes in economic variables that manifest themselves in changes in headship rates through price. A decrease in price causes an increase in headship rates and subsequently in the demand for housing stock. The major peaks correspond to decreases in either lagged rental price or sale price, or both. Troughs occur when headship rates and population grow relatively slowly, remain stable, or decrease. The troughs correspond to increases in either lagged rental price or sale price.

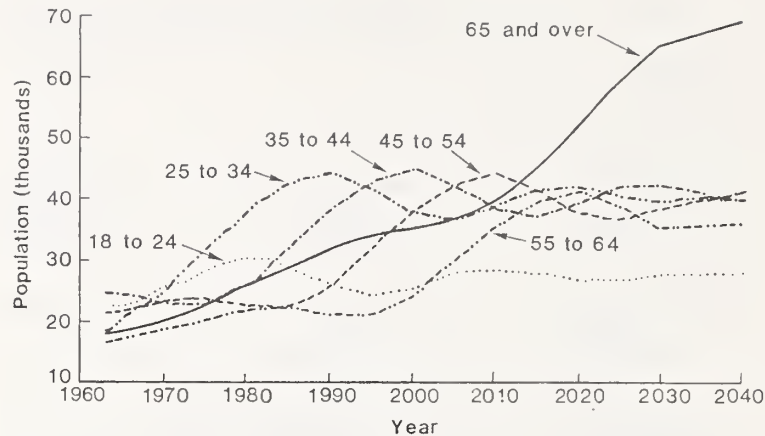


Figure 6—Population by age class.

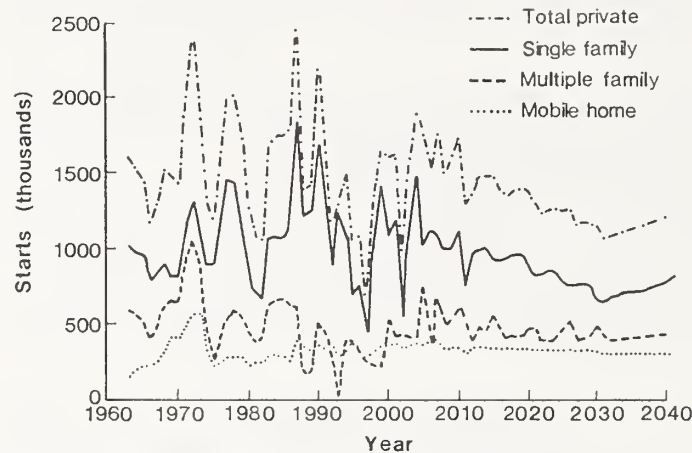


Figure 7—Housing starts with increasing discard rates.

Figures 7 and 8 display historical values and projections of housing starts that combine the change in demand for housing stock with projections of discards and unspecified additions to stock. The projections are volatile relative to historical values, especially when the relative stability of the projections of economic variables affecting headship rates is considered. Figure 1 reports historical values and future projections of headship rates and illustrates the relative stability of the projections. Further work is needed in this area to examine how discards and additions to stock buffer demand for new construction from shocks to housing demand. I expect that discards move countercyclically and additions to stock move procyclically to the change in demand for housing stock; that is, when the increase in demand for housing stock is large, discards will be low and additions will be high; when the increase in the demand for housing stock is small, the converse will hold. Although little data are available to support this notion, it would explain why housing starts move more smoothly than the changes in demand for housing stock.

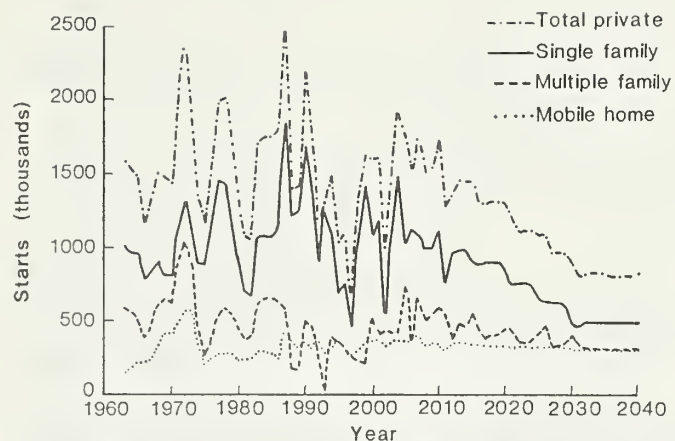


Figure 8—Housing starts with constant discard rates.

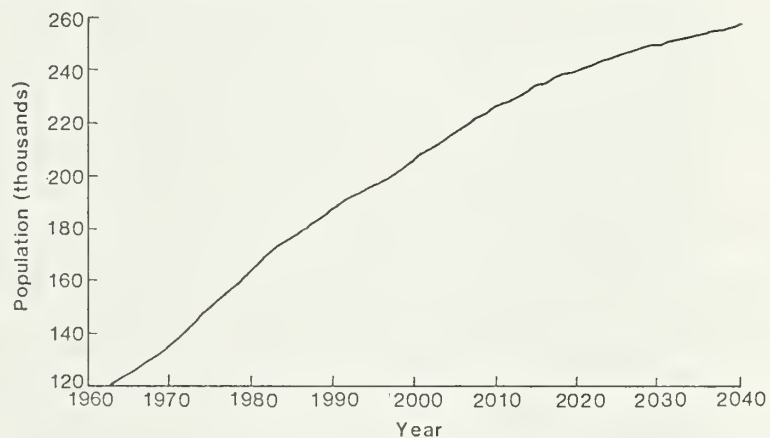


Figure 9—Population over 18.

After 2007, variation in economic variables and unspecified additions to stock is reduced to echoes of past cycles that are carried forward by the moving-average projection method. Demographics become even more important as the driver of the forecast. The growth rate of the total population decreases gradually (fig. 9), and the composition of population becomes more heavily weighted in the older age classes where change in headship rates between age groups is small. Starts steadily decrease in both scenarios. With increasing discard rates, the decline is less steep, however.

The proportion of households choosing single-family dwellings in the 30-34 and the 35-44 age classes is listed in appendix 3. The proportion of additional total private housing units (excluding mobile homes) that are single-family dwellings depends on both the rental price for housing (decreasing when price is high) and the age composition of the population (increasing as people move into the middle age classes and decreasing as the fraction of people over 65 and under 30 increases) (fig. 10).

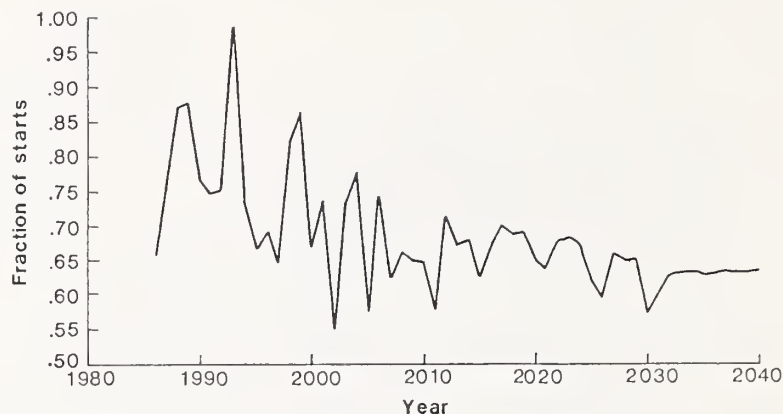


Figure 10—Single-family units as a fraction of total private housing starts.

## Conclusions

Progress has been made in providing an economic explanation for the level of housing starts. Demographics remain the strongest explanatory factor for long-term trends in the level of the housing stock. Rental price and current sale price are important in explaining short-run variation. Change in the demand for housing stock is a major component in annual housing starts. The other components, unspecified additions to stock and replacement of discarded housing stock, need to be examined closely in future work. Replacement of discards, in particular, may become an increasingly important source of demand for new construction as population growth slows and the housing stock ages. Housing start projections will be improved if potential responsiveness to economic variables by these two components is explored.

Progress has also been made in modeling composition of the housing stock by type of unit. The age distribution of the population and the rental price of housing influence the proportion of housing starts that are single- rather than multiple-family dwellings.

Finally, supply of new construction has been explicitly modeled to determine the current sale price of housing. The hypothesis that housing supply is perfectly elastic is not rejected, which implies that any amount of housing will be supplied at the market price—theoretically the minimum average cost of construction.

## Acknowledgments

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## Appendix 1

### Historical Data Series

The data are from annual series for 1963 through 1985 unless otherwise noted. Data are listed in tables 5 through 11.

Property tax rate is the average rate of 1 percent for 1973 to 1982 and is computed from the median tax payment and the median value for a single family (U.S. Department of Commerce, Bureau of the Census 1973-83). Gross depreciation rate, representing both economic depreciation and expenditure on maintenance and repair, is 2 percent (Margolis 1982).

Expected inflation is estimated by using the procedure of Modigliani and Shiller (1973) to model the term structure of interest rates. The long-term nominal interest rate is equal to the expected inflation rate plus the expected real interest rate and a risk premium. It is estimated as a polynomial distributed lag on the actual inflation rate and the ex post real interest rate. Quarterly data from 1950 to 1986 are used. The long-term rate is Moody's AAA corporate bond rate. Ex post real rate is the difference between short-term prime rate and the actual inflation rate. A third-degree polynomial is imposed on a lag length of 19 quarters. Expected inflation is:

$$\pi_t^e = \sum_{i=1}^{19} f_i * \pi_{t-i},$$

where the weights ( $f_i$ ) are the estimated lag coefficients (table 12).

The real interest rate is the difference between Moody's AAA corporate bond rate and the actual inflation rate.

**Table 5—Population (In thousands) by year and age class**

Year	Age class (years)							
	18-24	25-29	30-34	35-44	45-54	55-64	65+	18+
1963	18,268	10,974	11,436	24,584	21,346	16,436	17,778	120,822
1964	18,783	11,168	11,228	24,562	21,580	16,758	18,127	122,206
1965	20,293	11,340	11,125	24,447	21,839	17,077	18,451	124,572
1966	21,375	11,662	11,063	24,276	22,126	17,408	18,755	126,665
1967	22,327	12,093	11,063	24,038	22,440	17,753	19,071	128,785
1968	22,883	12,800	11,190	23,731	22,758	18,088	19,365	130,815
1969	23,724	13,290	11,390	23,384	23,047	18,390	19,680	132,905
1970	24,711	13,736	11,587	23,150	23,317	18,682	20,107	135,290
1971	25,873	14,041	11,917	22,978	23,519	18,963	20,561	137,852
1972	26,076	15,240	12,383	22,859	23,687	19,211	21,020	140,476
1973	26,636	15,786	13,153	22,810	23,807	19,428	21,525	143,145
1974	27,233	16,521	13,704	22,826	23,809	19,713	22,061	145,867
1975	28,006	17,280	14,191	22,831	23,756	20,045	22,696	148,805
1976	28,646	18,274	14,485	23,093	23,622	20,386	23,278	151,784
1977	29,173	18,277	15,721	23,563	23,370	20,780	23,892	154,776
1978	29,622	18,683	16,280	24,437	23,174	21,112	24,502	157,810
1979	30,047	19,178	17,025	25,176	22,942	21,448	25,134	160,950
1980	30,349	19,804	17,822	25,868	22,754	21,761	25,704	164,062
1981	30,430	20,306	18,853	26,460	22,614	21,955	26,236	166,854
1982	30,283	20,865	18,876	28,115	22,488	22,113	26,827	169,567
1983	29,916	21,321	19,281	29,368	22,472	22,233	27,428	172,019
1984	29,390	21,660	19,769	30,617	22,500	22,315	27,967	174,218
1985	28,749	21,884	20,343	31,839	22,597	22,334	28,536	176,282

Source: U.S. Department of Commerce, Bureau of the Census (1970, 1980, 1987).

Table 6—Predetermined economic variables by year, set 1

Year	CPI <sup>a</sup>	Actual inflation <sup>b</sup>	CPI less housing <sup>c</sup>	PPI <sup>d</sup>	DPI <sup>e</sup>	Mortgage rate <sup>f</sup>	Moody bond rate <sup>g</sup>	Marginal income tax
1962					1,170			
1963	92	0.013	92	95	1,207	0.058	0.043	0.179
1964	93	.016	93	95	1,291	.058	.044	.156
1965	94	.030	95	97	1,365	.057	.045	.148
1966	97	.028	97	100	1,431	.061	.051	.153
1967	100	.041	100	100	1,493	.063	.055	.157
1968	104	.053	104	103	1,551	.068	.062	.173
1969	110	.057	109	107	1,599	.077	.070	.181
1970	116	.042	114	110	1,668	.083	.080	.168
1971	121	.033	119	114	1,728	.076	.074	.164
1972	125	.060	123	119	1,797	.075	.072	.164
1973	133	.105	131	135	1,916	.078	.074	.170
1974	148	.087	146	160	1,896	.087	.086	.176
1975	161	.056	159	175	1,931	.088	.088	.178
1976	171	.063	168	183	2,001	.088	.084	.185
1977	182	.073	179	194	2,066	.088	.080	.187
1978	195	.108	191	209	2,167	.093	.087	.208
1979	218	.127	211	236	2,212	.105	.096	.190
1980	247	.098	236	269	2,214	.123	.119	.200
1981	272	.058	259	293	2,248	.141	.142	.203
1982	289	.030	274	299	2,261	.145	.138	.212
1983	297	.034	284	303	2,331	.121	.120	.216
1984	308	.035	295	310	2,470	.119	.127	.216
1985	319	.015	303	309	2,528	.111	.114	.222

<sup>a</sup> Consumer price index, all items, 1967=100 (U.S. Department of Labor, Bureau of Labor Statistics 1963-85a).

<sup>b</sup> Rate of change in consumer price index, all items.

<sup>c</sup> Consumer price index, all items except housing, 1967=100 (U.S. Department of Labor, Bureau of Labor Statistics 1963-85a) is used to deflate nominal house price.

<sup>d</sup> All commodity producer price index, 1967=100 (U.S. Department of Labor, Bureau of Labor Statistics 1963-85b).

<sup>e</sup> Disposable personal income in billion 1982 dollars (U.S. Department of Commerce, Bureau of Economic Activity 1963-85). Two-year moving average is used as proxy for permanent income.

<sup>f</sup> Conventional mortgage rate for new construction (U.S. Department of Commerce, Bureau of Economic Activity 1963-85).

<sup>g</sup> Average marginal income tax rate weighted by the number of returns in each marginal tax bracket (Barro and Sahasakul 1983; U.S. Department of the Treasury, Internal Revenue Service 1981-85).

**Table 7—Predetermined economic variables by year, set 2**

Year	Expected rate of:		Rental price <sup>b</sup>	Wood cost <sup>c</sup>	Labor cost <sup>d</sup>	Real site price <sup>e</sup>	Nominal house price <sup>f</sup>
	Inflation	Capital gain <sup>a</sup>					
1963	0.013	0.029	853.50	99.74	75.82	3,005	22,700
1964	.012	.014	1,238.03	100.19	79.23	3,157	22,600
1965	.018	.006	1,305.14	99.41	81.18	3,248	23,100
1966	.022	.000	1,436.31	101.18	82.82	3,242	24,100
1967	.028	.005	1,188.80	99.36	85.98	3,391	24,700
1968	.039	.005	995.22	116.65	88.82	3,632	25,900
1969	.047	.007	928.36	124.28	97.35	3,597	27,800
1970	.048	.000	1,234.69	102.15	106.17	4,039	28,700
1971	.048	.004	1,018.18	116.00	116.06	4,054	30,500
1972	.051	.008	841.46	131.80	123.89	4,067	32,500
1973	.064	.025	92.33	148.73	113.88	3,622	35,400
1974	.073	.014	370.24	124.65	101.12	3,229	38,700
1975	.076	.007	459.25	111.02	99.79	3,263	42,700
1976	.086	.004	274.00	129.45	102.74	3,533	45,900
1977	.078	.024	-63.43	144.84	104.17	3,518	51,100
1978	.075	.040	-420.46	153.90	103.10	3,624	58,300
1979	.096	.043	-837.22	143.75	96.05	4,021	66,700
1980	.106	.022	-44.27	118.32	90.25	4,247	74,200
1981	.103	-.001	1,199.15	107.96	87.93	4,032	81,100
1982	.086	-.018	2,272.12	100.00	99.99	4,052	83,900
1983	.059	-.011	2,283.59	111.05	104.87	3,990	86,400
1984	.039	-.007	2,720.03	106.38	103.25	4,077	89,600
1985	.024	-.002	2,783.26	108.60	115.21	4,210	92,200

<sup>a</sup> Expected rate of capital gain on housing is the expected difference between the rate of growth in house sale price and actual inflation and is estimated by the average rate of capital gain for the past 3 years.

<sup>b</sup> Rental price in 1967 dollars is computed by using equation (4).

<sup>c</sup> Wood price index (1967=100) for 4 wood products (softwood lumber, softwood plywood, hardwood lumber, and waferboard) is an average of prices, weighted by consumption quantities—the difference between production and net export quantities (Ruderman and Warren 1985; U.S. Department of Commerce, Bureau of the Census 1963-85a, 1963-85b, 1963-85c, 1963-85d; U.S. Department of Labor, Bureau of Labor Statistics 1963-85b; Warren 1985; Western Wood Products Association 1963-85).

<sup>d</sup> Labor cost index (1967=100) is constructed by using nominal carpenter wages deflated by the all-commodities producer price index (U.S. Department of Agriculture, Forest Service, Forest Products Laboratory, One Gifford Pinchot Dr., Madison, WI 53705-2398).

<sup>e</sup> Median price of an equivalent site (U.S. Department of Housing and Urban Development 1963-85).

<sup>f</sup> Sale price series for a constant quality house is constructed by using hedonic price equations (U.S. Department of Commerce, Bureau of the Census 1985).

**Table 8—Proportion of each age class occupying each housing type, by year and age class**

Age class and year	Single-family dwelling	Multiple-family dwelling	Mobile home	Age class and year	Single-family dwelling	Multiple-family dwelling	Mobile home
18-24 years:				25-29 years:			
1975	0.328	0.563	0.110	1975	0.522	0.411	0.068
1976	.337	.544	.119	1976	.530	.400	.070
1977	.325	.566	.109	1977	.516	.422	.062
1981	.315	.583	.102	1981	.516	.426	.058
1983	.325	.569	.106	1983	.505	.426	.069
Average	.326	.565	.109	Average	.518	.417	.065
30-34 years:				35-44 years:			
1975	.703	.243	.054	1975	.784	.182	.034
1976	.698	.256	.047	1976	.774	.193	.033
1977	.674	.282	.045	1977	.777	.189	.034
1981	.670	.287	.043	1981	.794	.203	.036
1983	.642	.312	.046	1983	.749	.218	.033
Average	.677	.276	.047	Average	.776	.197	.034
45-64 years:				65 years and over:			
1975	.781	.188	.032	1975	.678	.284	.038
1976	.779	.187	.034	1976	.672	.280	.048
1977	.776	.185	.040	1977	.667	.282	.051
1981	.781	.182	.037	1981	.688	.262	.050
1983	.775	.187	.039	1983	.657	.298	.045
Average	.778	.186	.036	Average	.672	.281	.046

Source: Unpublished tables (U.S. Department of Commerce, Bureau of the Census, Census of housing, Washington, DC.).

**Table 9—Occupancy rates (In percent) by year and housing type**

Year	Single-family dwelling	Multiple-family dwelling	Mobile home
1973	91.0	87.3	98.0
1974	92.6	87.6	98.0
1975	92.7	88.2	98.0
1976	92.5	87.7	98.0
1977	92.3	88.1	98.0
1978	92.3	87.9	98.0
1979	92.0	87.5	98.0
1980	92.3	87.4	98.0
1981	92.2	86.9	98.0
1983	92.0	86.0	98.0

Source: U.S. Department of Commerce, Bureau of the Census, 1973-83.

**Table 10—Headship rates (in percent) by year and age class**

Year	Age class (years)						
	18-24	25-29	30-34	35-44	45-54	55-64	65+
1963	15.8	40.1	46.4	48.8	51.5	55.8	60.0
1964	16.4	40.8	45.9	49.4	52.3	56.1	59.7
1965	17.0	42.5	46.1	48.9	52.4	56.7	60.5
1966	16.7	43.1	46.1	48.9	52.8	56.3	61.1
1967	15.9	44.0	46.2	49.5	52.4	56.3	62.1
1968	16.7	42.1	47.8	50.2	52.4	58.1	62.0
1969	17.2	44.5	48.1	50.1	52.6	58.3	62.1
1970	17.6	44.9	48.3	50.4	52.6	58.0	61.5
1971	18.4	44.7	48.1	51.0	53.5	58.2	61.8
1972	19.9	46.2	50.1	50.5	54.2	58.5	63.7
1973	20.7	46.7	50.5	51.6	54.1	58.3	63.5
1974	21.7	46.9	51.0	51.4	54.4	57.3	64.1
1975	21.2	46.8	51.6	52.0	54.3	57.4	64.4
1976	20.9	47.4	50.9	53.2	54.2	58.3	65.0
1977	20.5	45.9	49.5	53.0	55.2	56.7	62.0
1978	21.0	46.0	50.6	53.1	54.4	57.7	58.1
1979	21.1	45.2	48.9	52.9	54.9	57.3	62.8
1980	21.1	45.2	50.4	53.7	55.3	56.0	62.8
1981	21.2	47.2	51.3	54.6	56.3	57.9	64.4
1982	20.2	45.7	51.9	54.5	55.6	58.5	64.5
1983	19.0	44.5	50.0	54.5	55.0	58.8	64.4
1984	18.7	45.5	50.4	54.2	55.4	58.8	64.0
1985	18.9	44.0	51.0	54.9	55.9	58.5	63.6

Sources: Marcin, 1978 and U.S. Department of Commerce, Bureau of the Census, 1977-85.

**Table 11—Housing starts (in thousands) by year**

Year	Single-family dwellings	Multiple-family dwellings	Total private <sup>a</sup>	Mobile homes	Total
1963	1,012	591	1,603	151	1,754
1964	971	558	1,529	191	1,720
1965	964	509	1,473	216	1,689
1966	779	386	1,165	217	1,382
1967	844	448	1,292	240	1,532
1968	899	608	1,508	318	1,826
1969	811	656	1,467	413	1,879
1970	813	621	1,434	401	1,835
1971	1,151	901	2,052	497	2,549
1972	1,309	1,047	2,357	576	2,933
1973	1,132	913	2,045	567	2,612
1974	888	450	1,338	329	1,667
1975	892	268	1,160	212	1,373
1976	1,162	375	1,538	246	1,784
1977	1,451	536	1,987	277	2,264
1978	1,433	587	2,020	276	2,296
1979	1,194	551	1,745	277	2,023
1980	852	440	1,292	222	1,514

See footnote on next page.

**Table 11—Housing starts (in thousands) by year (continued)**

1981	705	379	1,084	241	1,325
1982	663	400	1,062	240	1,302
1983	1,068	635	1,703	296	1,999
1984	1,084	665	1,750	296	2,045
1985	1,072	669	1,742	284	2,026

Source: U.S. Department of Commerce, Bureau of Economic Analysis, 1963-85.

<sup>a</sup> Total private housing starts refers to the sum of single- and multiple-family private dwellings.

**Table 12—Distributed lag coefficient for expected inflation**

Lag	Coefficient
t	0.1492
t- 1	.1094
t- 2	.0080
t- 3	.0599
t- 4	.0476
t- 5	.0418
t- 6	.0412
t- 7	.0445
t- 8	.0505
t- 9	.0577
t-10	.0649
t-11	.0708
t-12	.0740
t-13	.0732
t-14	.0672
t-15	.0546
t-16	.0341
t-17	.0043
t-18	-.0359
t-19	-.0880

## Appendix 2

### Estimation of Headship Rate Equation

The decision to form a household is a binary choice (either yes or no) made by individuals. Because it is the sample proportion of positive responses that is observed, it is appropriate to use a logit model described by Theil (1970) and used by Marcin (1978) for headship rate for equation (3). The dependent variable (the logit) is the natural logarithm of the odds of a positive choice given that the maximum probability of a positive choice is  $M$ . The parameter  $M$  sets a maximum value for headship rate for an age class. Values for  $M$  used here are established by Marcin and are based on historical marriage, divorce, and cohabitation patterns (table 13). The logit is a linear function of the independent variables. The general model is:

$$L_{a,t} = \ln[h_{a,t}/(M_a - h_{a,t})] = \sum_i b_i x_{i,t} + u_t .$$

Headship rate is computed as:

$$h_{a,t} = M_a / [1 - \exp(L_{a,t})] ,$$

and is bounded by zero and  $M$ . The random disturbance ( $u_t$ ) has a mean of zero and variance of  $1/[n_{a,t} h_{a,t} (M_a - h_{a,t})]$  where  $n_{a,t}$  is the estimate of the population in age class  $a$ . Correction must be made for classic heteroscedasticity.<sup>1</sup> Variables are transformed so that

$$x'_t = x_t * [n_{a,t} h_{a,t} (M_a - h_{a,t})]^{1/2} ,$$

for all variables including  $L_t$ . The new error term ( $u'_t$ ) has a mean of zero and a variance of one. The transformed equation is estimated by using ordinary least squares.

The age classes ( $a$ ) are 18-24, 25-29, 30-34, 35-44, 45-54, 55-64, and 65 and over. A single equation is estimated for all age classes. Hypotheses regarding the coefficients are tested by using the likelihood ratio test (Judge and others 1982). In the unrestricted case, dummy variables ( $D$ ) are included for all age classes and all variables:

$$\begin{aligned} L_t = & \sum_{d=i}^A b_{0a} D_a + \sum_{d=i}^A b_{1a} D_a t + \sum_{d=i}^A b_{2a} D_a y_t + \sum_{d=i}^A b_{3a} D_a r_t \\ & + \sum_{d=i}^A b_{4a} D_a r_{t-1} + \sum_{d=i}^A b_{5a} D_a p_t + \sum_{d=i}^A b_{6a} D_a p_{t-1} + u_t . \end{aligned}$$

<sup>1</sup>  $E(u_t^2) = z_t$  and  $E(u_t u_{t-1}) = 0$ .

**Table 13—Maximum headship rates (in percent) by age class**

Age class	Maximum headship rate
18-24	30
25-29	56
30-34	56
35-44	57
45-54	58
55-64	60
65 and over	68

In the first set of regressions, hypotheses are tested for whether current or lagged price variables should appear in the equation. Likelihood ratios that follow the F-distribution are reported in table 14. The hypothesis that the coefficients for current rental price and lagged sale price are zero cannot be rejected at the 1-percent significance level. Those coefficients are dropped, and the resulting equation becomes the base unrestricted case for the second set of regressions, in which the following hypotheses are tested:

1. Coefficients are equal over age classes for all variables,  $b_{ia} = b_{ia}'$  for all  $i$  and  $a$ .
2. Coefficients are equal over age classes for all variables except the intercept.
3. Coefficients are equal over age classes for time and income only.
4. Coefficients are equal over age classes for rental price and sale price only.

Results are in table 15. Only hypothesis 3 is not rejected. In that equation, coefficient estimates for rental price in two age groups are positive. The coefficient estimate for income is not significantly different from zero ( $t$ -statistic is 0.4). This is probably due to multicollinearity between income and time. One final hypothesis is tested and is not rejected (table 15).

5. Coefficients are equal over age class for time only, coefficient for income is zero for all age classes, and coefficient for rental price is zero for the 35-44 and 55-64 age groups.

Estimates for the final equation are reported in table 3.

**Table 14—Hypothesis test results, 1st set**

Hypothesis	Number of restrictions (q)	Likelihood ratio $F_{q,105}$	Critical value at 1-percent significance level
$r_t = 0, p_t = 0$	14	2.61	2.29
$r_{t-1} = 0, p_{t-1} = 0$	14	2.75	2.29
$r_t = 0, p_{t-1} = 0$	14	2.22	2.29
$r_{t-1} = 0, p_t = 0$	14	2.28	2.29

**Table 15—Hypothesis test results, 2d set**

Hypothesis	Number of restrictions (q)	Likelihood ratio $F_{q,119}$	Critical value at 1-percent significance level
1	30	97.13	1.76
2	24	5.77	1.95
3	12	1.49	2.34
4	12	3.92	2.34
5	18	1.39	2.15

## Appendix 3

### Projection of Exogenous Variables

Projection of data series underlying housing start projections are listed in tables 16 through 26.

Property tax and depreciation rates are constant at 1 and 2 percent, respectively. The marginal income tax rate drops to 20 percent in 1986, reflecting the reform of Federal income tax law, and stays constant at that level.

**Table 16—Population (In thousands) by year and age class<sup>a</sup>**

Year	Age class (years)							Total 18+
	18-24	25-29	30-34	35-44	45-54	55-64	65+	
1986	27,973	22,136	20,848	33,142	22,823	22,230	29,173	178,325
1987	27,539	22,087	21,237	34,382	23,492	21,976	29,807	180,521
1988	27,092	22,034	21,633	35,646	24,174	21,714	30,451	182,743
1989	26,632	21,978	22,034	36,933	24,867	21,443	31,106	184,993
1990	26,158	21,917	22,442	38,245	25,573	21,163	31,771	187,270
1991	25,812	21,443	22,440	39,171	26,781	21,172	32,236	189,054
1992	25,447	20,950	22,429	40,098	28,001	21,171	32,695	190,792
1993	25,067	20,442	22,410	41,029	29,236	21,163	33,153	192,499
1994	24,670	19,915	22,381	41,961	30,481	21,147	33,605	194,160
1995	24,256	19,372	22,343	42,894	31,736	21,122	34,053	195,776
1996	24,487	19,135	21,868	43,361	32,924	21,710	34,297	197,782
1997	24,714	18,888	21,378	43,820	34,119	22,299	34,533	199,750
1998	24,936	18,630	20,872	44,272	35,323	22,891	34,762	201,686
1999	25,154	18,363	20,353	44,718	36,535	23,485	34,983	203,591
2000	25,368	18,087	19,820	45,159	37,756	24,081	35,199	205,471

See footnote on next page.

Table 16—Population (in thousands) by year and age class<sup>a</sup> (continued)

Year	Age class (years)							Total 18+
	18-24	25-29	30-34	35-44	45-54	55-64	65+	
2001	25,884	18,121	19,577	44,668	38,657	25,225	35,487	207,619
2002	26,401	18,152	19,326	44,159	39,562	26,381	35,772	209,753
2003	26,922	18,179	19,068	43,636	40,474	27,548	36,054	211,881
2004	27,446	18,205	18,804	43,099	41,393	28,727	36,336	214,010
2005	27,971	18,228	18,532	42,547	42,317	29,917	36,614	216,126
2006	28,160	18,638	18,562	41,818	42,750	31,019	37,219	218,165
2007	28,347	19,052	18,590	41,073	43,183	32,132	37,828	220,204
2008	28,497	19,444	18,592	40,264	43,563	33,214	38,391	221,965
2009	28,649	19,840	18,594	39,444	43,946	34,306	38,960	223,739
2010	28,857	20,280	18,632	38,690	44,417	35,478	39,610	225,964
2011	28,625	20,404	18,984	38,362	43,798	36,210	40,625	227,007
2012	28,466	20,582	19,389	38,131	43,287	37,044	41,755	228,653
2013	28,300	20,759	19,795	37,890	42,762	37,880	42,891	230,276
2014	28,126	20,934	20,202	37,639	42,223	38,719	44,032	231,874
2015	27,944	21,107	20,609	37,378	41,669	39,559	45,176	233,443
2016	27,751	21,028	20,788	37,804	40,955	39,949	46,515	234,789
2017	27,550	20,944	20,963	38,226	40,224	40,334	47,858	236,100
2018	27,340	20,855	21,136	38,644	39,477	40,714	49,204	237,369
2019	27,122	20,760	21,305	39,057	38,714	41,088	50,551	238,597
2020	26,895	20,659	21,471	39,465	37,934	41,456	51,899	239,777
2021	26,916	20,488	21,386	40,026	37,708	40,995	53,396	240,915
2022	26,929	20,311	21,294	40,582	37,471	40,519	54,893	242,000
2023	26,936	20,127	21,197	41,132	37,222	40,030	56,387	243,030
2024	26,935	19,936	21,093	41,674	36,960	39,525	57,877	244,001
2025	26,927	19,738	20,982	42,208	36,687	39,006	59,360	244,910
2026	27,106	19,723	20,815	42,298	37,100	38,322	60,600	245,965
2027	27,279	19,703	20,641	42,376	37,505	37,622	61,829	246,954
2028	27,444	19,676	20,459	42,442	37,901	36,907	63,045	247,873
2029	27,601	19,642	20,270	42,494	38,286	36,177	64,247	248,718
2030	27,750	19,603	20,074	42,533	38,660	35,433	65,433	249,485
2031	27,795	19,709	20,117	42,303	38,959	35,517	65,810	250,209
2032	27,839	19,816	20,160	42,072	39,258	35,602	66,188	250,935
2033	27,884	19,924	20,203	41,841	39,558	35,687	66,567	251,663
2034	27,928	20,031	20,246	41,608	39,860	35,773	66,948	252,393
2035	27,973	20,139	20,289	41,374	40,162	35,858	67,329	253,125
2036	28,018	20,248	20,333	41,139	40,465	35,944	67,712	253,858
2037	28,062	20,356	20,376	40,904	40,770	36,030	68,096	254,594
2038	28,107	20,465	20,420	40,667	41,075	36,116	68,481	255,331
2039	28,152	20,575	20,463	40,429	41,381	36,202	68,867	256,070
2040	28,197	20,684	20,507	40,191	41,688	36,288	69,254	256,810

<sup>a</sup> Series 14 (U.S. Department of Commerce, Bureau of the Census 1984) assumes middle fertility, middle mortality, and high immigration rates.

**Table 17—Predetermined economic variables by years, set 1**

Year	CPI <sup>a,b</sup>	Actual inflation <sup>c</sup>	CPI less housing <sup>d</sup>	PPI <sup>a,e</sup>	DPI <sup>a,f</sup>	Mortgage rate <sup>g,h</sup>	Moody bond rate <sup>g</sup>	Marginal income tax rate
1986	323	0.036	305	313	2,602	0.103	0.097	0.224
1987	335	.044	317	321	2,714	.098	.096	.200
1988	350	.049	330	334	2,755	.107	.109	.200
1989	368	.048	343	350	2,810	.119	.120	.200
1990	386	.041	357	364	2,851	.097	.095	.200
1991	402	.043	371	375	2,952	.092	.088	.200
1992	420	.047	385	389	3,054	.092	.089	.200
1993	440	.050	401	405	3,157	.094	.091	.200
1994	462	.056	417	423	3,261	.096	.094	.200
1995	489	.053	433	441	3,366	.100	.098	.200
1996	515	.053	450	461	3,472	.102	.101	.200
1997	543	.058	468	480	3,580	.121	.124	.200
1998	576	.041	487	500	3,688	.112	.113	.200
1999	599	.044	506	522	3,799	.102	.101	.200
2000	626	.047	526	545	3,910	.097	.095	.200
2001	657	.050	547	569	4,015	.096	.094	.200
2002	690	.056	569	593	4,122	.112	.113	.200
2003	730	.038	591	616	4,229	.101	.100	.200
2004	758	.045	615	641	4,337	.091	.088	.200
2005	792	.046	639	667	4,446	.092	.089	.200
2006	830	.049	665	693	4,556	.093	.091	.200
2007	871	.046	691	720	4,667	.095	.092	.200
2008	912	.047	719	749	4,779	.093	.090	.200
2009	956	.048	747	778	4,892	.094	.091	.200
2010	1,003	.050	777	809	5,005	.096	.093	.200
2011	1,055	.040	808	840	5,111	.098	.096	.200
2012	1,098	.047	840	873	5,218	.098	.095	.200
2013	1,150	.047	873	908	5,326	.096	.093	.200
2014	1,206	.046	908	943	5,434	.095	.092	.200
2015	1,263	.044	944	980	5,544	.094	.091	.200
2016	1,319	.044	981	1,019	5,654	.094	.091	.200
2017	1,378	.043	1,020	1,059	5,765	.093	.090	.200
2018	1,438	.042	1,061	1,100	5,876	.092	.089	.200
2019	1,500	.043	1,103	1,143	5,989	.090	.087	.200
2020	1,567	.041	1,147	1,188	6,102	.089	.086	.200
2021	1,632	.041	1,192	1,235	6,240	.088	.086	.200
2022	1,699	.041	1,239	1,283	6,378	.088	.085	.200
2023	1,770	.040	1,289	1,334	6,517	.087	.084	.200
2024	1,842	.040	1,340	1,386	6,657	.086	.083	.200
2025	1,917	.039	1,393	1,440	6,798	.085	.082	.200
2026	1,993	.039	1,448	1,497	6,939	.084	.081	.200
2027	2,073	.039	1,506	1,556	7,081	.084	.081	.200
2028	2,155	.039	1,566	1,617	7,224	.083	.080	.200
2029	2,240	.039	1,628	1,680	7,367	.083	.080	.200
2030	2,330	.039	1,692	1,746	7,511	.082	.080	.200
2031	2,424	.039	1,760	1,811	7,657	.082	.079	.200
2032	2,521	.040	1,829	1,878	7,805	.082	.079	.200
2033	2,622	.040	1,902	1,948	7,956	.082	.079	.200
2034	2,729	.040	1,978	2,020	8,109	.082	.079	.200
2035	2,840	.040	2,056	2,094	8,264	.082	.079	.200
2036	2,957	.040	2,138	2,171	8,423	.082	.079	.200

See footnotes on next page.

**Table 17—Predetermined economic variables by years, set 1 (continued)**

Year	CPI <sup>a,b</sup>	Actual inflation <sup>c</sup>	CPI less housing <sup>d</sup>	PPI <sup>a,e</sup>	DPI <sup>a,f</sup>	Mortgage rate <sup>g,h</sup>	Moody bond rate <sup>g</sup>	Marginal income tax rate
2037	3,079	.041	2,223	2,251	8,584	.082	.079	.200
2038	3,206	.041	2,311	2,333	8,748	.082	.079	.200
2039	3,340	.041	2,403	2,417	8,916	.082	.079	.200
2040	3,479	.041	2,498	2,505	9,086	.082	.079	.200

<sup>a</sup> Projection by Wharton Econometrics (1987) until 2007 and assumed to grow at 20-year moving average rate thereafter.

<sup>b</sup> Consumer price index, all items, 1967=100.

<sup>c</sup> Rate of change in consumer price, all items.

<sup>d</sup> Consumer price index, all items except housing (1967=100) is estimated by using ordinary least squares (t-statistic is 69.5): CPI, less housing = 0.9497 \* CPI, all items.

<sup>e</sup> All-commodities producer price index, 1967=100.

<sup>f</sup> Disposable personal income in billion 1982 dollars.

<sup>g</sup> Projection by Wharton Econometrics (1987) until 2007 and is a 20-year moving average of past values thereafter.

<sup>h</sup> Conventional mortgage rate for new construction.

**Table 18—Predetermined economic variables by year, set 2**

Year	Expected rate of:		Rental price <sup>c</sup>	Wood cost <sup>d</sup>	Labor cost <sup>e</sup>	Real site price <sup>f</sup>	Nominal house price <sup>g</sup>
	Inflation <sup>a</sup>	Capital gain <sup>b</sup>					
1986	0.024	-0.017	2,387	110.67	112.15	4,275	90,000
1987	.033	-.015	2,383	113.59	109.09	4,341	93,072
1988	.034	-.007	2,482	110.63	106.03	4,408	99,344
1989	.038	.019	2,206	113.90	102.96	4,476	105,615
1990	.047	.009	1,876	119.92	99.90	4,546	107,925
1991	.046	.002	1,910	125.36	100.74	4,616	111,849
1992	.046	-.006	2,121	127.00	101.59	4,687	117,286
1993	.045	.002	1,893	126.76	102.43	4,759	123,217
1994	.047	.005	1,885	127.98	103.27	4,833	129,988
1995	.051	.005	2,022	132.40	104.11	4,908	138,160
1996	.053	.006	2,118	132.55	104.95	4,983	145,981
1997	.055	.012	2,491	133.83	105.79	5,060	157,423
1998	.053	.004	2,513	137.18	106.62	5,139	163,663
1999	.048	.003	2,267	141.21	107.46	5,218	170,435
2000	.048	-.005	2,379	143.32	108.30	5,299	178,569
2001	.047	-.002	2,227	137.17	109.13	5,380	185,738
2002	.046	.007	2,495	139.57	109.97	5,463	199,770
2003	.049	-.002	2,448	142.67	110.81	5,548	206,657
2004	.047	.001	2,110	144.56	111.65	5,634	214,138
2005	.047	-.007	2,395	143.71	112.49	5,721	224,470
2006	.045	.001	2,169	144.02	113.43	5,809	235,309
2007	.044	.002	2,203	145.52	114.36	5,899	247,225
2008	.047	.002	2,192	147.92	115.29	5,990	259,045
2009	.048	.002	2,244	148.53	116.22	6,082	271,466
2010	.048	.002	2,316	149.12	117.15	6,176	285,139

See footnotes on next page.

**Table 18—Predetermined economic variables by year, set 2 (continued)**

Year	Expected rate of:		Rental price <sup>c</sup>	Wood cost <sup>d</sup>	Labor cost <sup>e</sup>	Real site price <sup>f</sup>	Nominal house price <sup>g</sup>
	Inflation <sup>a</sup>	Capital gain <sup>b</sup>					
2011	.046	.000	2,461	147.67	118.08	6,272	298,648
2012	.046	.002	2,398	149.19	119.00	6,368	312,890
2013	.047	.002	2,386	151.07	119.93	6,467	327,602
2014	.045	.002	2,336	151.23	120.86	6,567	342,536
2015	.045	.000	2,422	151.53	121.78	6,668	358,592
2016	.046	-.001	2,416	149.72	123.11	6,771	374,264
2017	.044	.001	2,329	151.50	124.43	6,876	392,320
2018	.043	.003	2,256	153.40	125.76	6,982	411,207
2019	.043	.005	2,174	154.02	127.08	7,090	430,374
2020	.043	.004	2,182	153.74	128.41	7,199	450,043
2021	.042	.003	2,194	151.64	129.63	7,311	469,646
2022	.041	.004	2,128	154.15	130.84	7,423	492,956
2023	.041	.007	2,039	156.08	132.06	7,538	517,038
2024	.040	.008	1,969	156.75	133.28	7,655	541,539
2025	.040	.007	1,989	156.56	134.50	7,773	566,695
2026	.040	.005	2,040	152.77	135.77	7,893	590,454
2027	.039	.007	1,973	156.41	137.04	8,015	620,952
2028	.039	.009	1,910	158.81	138.31	8,139	652,072
2029	.039	.011	1,836	158.81	139.58	8,264	682,877
2030	.039	.009	1,904	158.25	140.85	8,392	714,819
2031	.039	.007	1,967	158.82	142.12	8,522	747,913
2032	.039	.007	1,993	159.34	143.40	8,653	782,532
2033	.040	.007	2,014	159.79	144.67	8,787	818,647
2034	.040	.007	2,032	160.26	145.94	8,923	856,399
2035	.040	.006	2,058	160.74	147.21	9,060	895,930
2036	.040	.006	2,084	161.34	148.48	9,200	937,428
2037	.040	.006	2,105	161.88	149.75	9,342	980,711
2038	.041	.006	2,131	162.35	151.02	9,487	1,025,745
2039	.041	.005	2,155	162.82	152.30	9,633	1,072,835
2040	.041	.005	2,178	163.33	153.57	9,782	1,121,936

<sup>a</sup> Polynomial-distributed lag of past values.

<sup>b</sup> 3-year moving average of past values.

<sup>c</sup> Projected in 1967 dollars by using equation (4).

<sup>d</sup> Projection of wood price index (1967=100) was constructed by using preliminary Timber Assessment Market Model (Adams and Haynes 1980) projections of prices and consumption quantities for softwood lumber, softwood plywood, hardwood lumber, and waferboard.

<sup>e</sup> Labor cost index (1967=100) was constructed from projections of construction employment and earnings (U.S. Department of Commerce, Bureau of Economic Analysis 1985).

<sup>f</sup> Assumed to increase at its average growth rate over the sample period.

<sup>g</sup> Projected by using estimate of equation (5) and inflating by all-commodities producer price index.

**Table 19—Occupancy rates (in percent) by year and housing type<sup>a</sup>**

Year	Single-family dwelling	Multiple-family dwelling	Mobile home
1986	92.1	87.1	98.0
1987	92.0	87.0	98.0
1988	92.1	87.1	98.0
1989	92.1	87.1	98.0
1990	92.2	87.3	98.0
1991	92.4	87.4	98.0
1992	92.3	87.3	98.0
1993	92.2	87.2	98.0
1994	92.2	87.2	98.0
1995	92.3	87.3	98.0
1996	92.3	87.3	98.0
1997	92.3	87.3	98.0
1998	92.3	87.3	98.0
1999	92.3	87.3	98.0
2000	92.3	87.3	98.0
2001	92.3	87.3	98.0
2002	92.3	87.3	98.0
2003	92.3	87.3	98.0
2004	92.3	87.3	98.0
2005	92.3	87.3	98.0
2006	92.2	87.2	98.0
to			
2040	92.2	87.2	98.0

<sup>a</sup> Fluctuation about past average values follows movements in the projections made by Wharton Econometrics (1987).

**Table 20—Two scenarios for discard rates, by year<sup>a</sup>**

Year	Increasing rates		Constant rates	
	Single-family dwelling	Multiple-family dwelling	Single-family dwelling	Multiple-family dwelling
1986	0.0035	0.0053	0.0035	0.0053
1987	.0035	.0052	.0035	.0052
1988	.0035	.0051	.0035	.0051
1989	.0033	.0053	.0033	.0053
1990	.0032	.0053	.0032	.0053
1991	.0034	.0051	.0034	.0051
1992	.0034	.0050	.0034	.0050
1993	.0034	.0050	.0034	.0050
1994	.0034	.0050	.0034	.0050
1995	.0034	.0050	.0034	.0050
1996	.0034	.0050	.0034	.0050

See footnote on next page.

Table 20—Two scenarios for discard rates, by year<sup>a</sup> (continued)

Year	Increasing rates		Constant rates	
	Single-family dwelling	Multiple-family dwelling	Single-family dwelling	Multiple-family dwelling
1997	.0034	.0050	.0034	.0050
1998	.0034	.0050	.0034	.0050
1999	.0034	.0050	.0034	.0050
2000	.0034	.0050	.0034	.0050
2001	.0034	.0050	.0034	.0050
2002	.0034	.0050	.0034	.0050
2003	.0034	.0050	.0034	.0050
2004	.0034	.0050	.0034	.0050
2005	.0034	.0050	.0034	.0050
2006	.0034	.0050	.0034	.0050
2007	.0034	.0050	.0034	.0050
2008	.0034	.0050	.0034	.0050
2009	.0034	.0050	.0034	.0050
2010	.0034	.0050	.0034	.0050
2011	.0034	.0050	.0034	.0050
2012	.0035	.0050	.0034	.0050
2013	.0035	.0051	.0034	.0050
2014	.0036	.0052	.0034	.0050
2015	.0037	.0052	.0034	.0050
2016	.0037	.0053	.0034	.0050
2017	.0038	.0054	.0034	.0050
2018	.0039	.0055	.0034	.0050
2019	.0039	.0055	.0034	.0050
2020	.0040	.0056	.0034	.0050
2021	.0041	.0057	.0034	.0050
2022	.0042	.0058	.0034	.0050
2023	.0043	.0059	.0034	.0050
2024	.0044	.0060	.0034	.0050
2025	.0045	.0061	.0034	.0050
2026	.0046	.0062	.0034	.0050
2027	.0047	.0063	.0034	.0050
2028	.0048	.0064	.0034	.0050
2029	.0049	.0065	.0034	.0050
2030	.0050	.0066	.0034	.0050
2031	.0051	.0067	.0034	.0050
2032	.0052	.0068	.0034	.0050
2033	.0053	.0069	.0034	.0050
2034	.0054	.0070	.0034	.0050
2035	.0055	.0071	.0034	.0050
2036	.0056	.0072	.0034	.0050
2037	.0057	.0073	.0034	.0050
2038	.0058	.0074	.0034	.0050
2039	.0059	.0075	.0034	.0050
2040	.0060	.0076	.0034	.0050

<sup>a</sup> Projected by Wharton Econometrics (1987) until 2007 with increase gradually or constant thereafter. Some adjustments have been made to prevent negative values for housing starts.

**Table 21—Unspecified additions to housing stock  
(in thousands) by year<sup>a</sup>**

Year	Single- family dwelling	Multiple- family dwelling	Mobile home
1986	130	350	0
1987	150	400	0
1988	150	400	0
1989	150	15	0
1990	448	233	57
1991	142	211	50
1992	500	306	-54
1993	313	221	33
1994	360	58	29
1995	435	16	-85
1996	418	89	41
1997	352	193	58
1998	224	168	58
1999	123	121	21
2000	265	70	9
2001	199	31	6
2002	365	105	13
2003	171	91	11
2004	79	0	10
2005	160	49	11
2006	271	28	-23
2007	175	6	-17
2008	141	28	27
2009	119	50	29
2010	135	36	28
2011	101	1	43
2012	225	132	14
2013	228	122	15
2014	231	111	15
2015	235	99	16
2016	239	94	14
2017	243	89	13
2018	232	80	16
2019	229	75	15
2020	224	75	14
2021	215	78	18
2022	207	77	17
2023	201	73	16
2024	201	69	14
2025	204	67	14
2026	201	67	14
2027	201	68	14
2028	195	67	14
2029	196	66	14
2030	200	68	15

*See footnote on next page.*

**Table 21—Unspecified additions to housing stock  
(in thousands) by year<sup>a</sup> (continued)**

Year	Single- family dwelling	Multiple- family dwelling	Mobile home
2031	202	69	15
2032	199	71	16
2033	200	73	18
2034	203	75	17
2035	206	76	17
2036	209	78	16
2037	213	81	15
2038	213	79	15
2039	212	77	15
2040	211	75	15

<sup>a</sup> Projected by Wharton Econometrics (1987) and is a 20-year moving average of past values thereafter.

**Table 22—Headship rates (in percent) by age class<sup>a</sup>**

Year	Age class (years)						
	18-24	25-29	30-34	35-44	45-54	55-64	65+
1986	20.2	46.8	51.6	54.9	56.0	58.7	65.0
1987	21.5	48.2	52.2	55.1	56.2	58.8	65.3
1988	21.6	48.2	52.3	55.2	56.3	58.8	65.3
1989	21.2	47.5	52.1	55.3	56.3	58.8	65.1
1990	22.5	49.0	52.7	55.4	56.5	59.0	65.5
1991	23.5	49.9	53.1	55.5	56.6	59.0	65.8
1992	23.7	50.1	53.2	55.6	56.7	59.1	65.8
1993	23.5	50.0	53.3	55.7	56.8	59.1	65.9
1994	24.0	50.3	53.4	55.8	56.8	59.1	66.0
1995	23.9	50.1	53.4	55.9	56.9	59.1	65.9
1996	23.8	49.9	53.4	56.0	56.9	59.1	65.9
1997	23.3	49.2	53.3	56.0	56.9	59.0	65.7
1998	23.2	49.2	53.4	56.1	57.0	59.1	65.9
1999	23.5	49.6	53.5	56.2	57.0	59.2	66.0
2000	24.1	50.1	53.7	56.2	57.1	59.2	66.1
2001	24.3	50.3	53.9	56.3	57.2	59.3	66.2
2002	24.2	49.9	53.8	56.3	57.2	59.2	66.1
2003	24.3	50.2	53.9	56.4	57.2	59.3	66.3
2004	24.8	50.7	54.1	56.4	57.3	59.3	66.4
2005	25.3	51.2	54.3	56.5	57.4	59.4	66.5
2006	25.2	51.1	54.3	56.5	57.4	59.4	66.5
2007	25.5	51.4	54.4	56.5	57.4	59.4	66.6
2008	25.7	51.5	54.5	56.6	57.5	59.4	66.6
2009	25.8	51.6	54.5	56.6	57.5	59.4	66.7
2010	25.9	51.7	54.6	56.6	57.5	59.5	66.7
2011	26.0	51.8	54.6	56.6	57.5	59.5	66.8
2012	26.0	51.8	54.7	56.7	57.6	59.5	66.8
2013	26.2	52.0	54.8	56.7	57.6	59.5	66.9
2014	26.4	52.1	54.8	56.7	57.6	59.5	66.9
2015	26.6	52.3	54.9	56.7	57.6	59.6	67.0
2016	26.7	52.4	54.9	56.8	57.7	59.6	67.0
2017	26.8	52.5	55.0	56.8	57.7	59.6	67.1

See footnote on next page.

Table 22—Headship rates (in percent) by age class<sup>a</sup> (continued)

Year	Age class (years)						
	18-24	25-29	30-34	35-44	45-54	55-64	65+
2018	27.0	52.7	55.0	56.8	57.7	59.6	67.1
2019	27.1	52.8	55.1	56.8	57.7	59.6	67.1
2020	27.3	53.0	55.2	56.8	57.7	59.7	67.2
2021	27.5	53.2	55.2	56.8	57.8	59.7	67.2
2022	27.5	53.2	55.2	56.8	57.8	59.7	67.2
2023	27.6	53.3	55.3	56.8	57.8	59.7	67.3
2024	27.8	53.4	55.3	56.9	57.8	59.7	67.3
2025	27.9	53.5	55.4	56.9	57.8	59.7	67.3
2026	28.0	53.7	55.4	56.9	57.8	59.7	67.4
2027	28.0	53.7	55.4	56.9	57.8	59.7	67.4
2028	28.1	53.7	55.4	56.9	57.8	59.7	67.4
2029	28.2	53.8	55.5	56.9	57.9	59.7	67.4
2030	28.3	53.9	55.5	56.9	57.9	59.8	67.4
2031	28.4	54.0	55.5	56.9	57.9	59.8	67.5
2032	28.4	54.0	55.5	56.9	57.9	59.8	67.5
2033	28.5	54.1	55.6	56.9	57.9	59.8	67.5
2034	28.5	54.1	55.6	56.9	57.9	59.8	67.5
2035	28.6	54.2	55.6	56.9	57.9	59.8	67.5
2036	28.6	54.2	55.6	56.9	57.9	59.8	67.6
2037	28.7	54.3	55.6	56.9	57.9	59.8	67.6
2038	28.7	54.3	55.6	56.9	57.9	59.8	67.6
2039	28.8	54.4	55.7	57.0	57.9	59.8	67.6
2040	28.8	54.4	55.7	57.0	57.9	59.8	67.6

<sup>a</sup> Projected by using estimate of headship rate equation.

Table 23—Fraction of age class by year, age class, and housing type<sup>a</sup>

Year	30-34 age class			35-44 age class		
	Single-family dwelling	Multiple-family dwelling	Mobile home	Single-family dwelling	Multiple-family dwelling	Mobile home
1986	0.645	0.308	0.047	0.748	0.218	0.034
1987	.645	.308	.047	.748	.218	.034
1988	.643	.310	.047	.747	.219	.034
1989	.649	.304	.047	.750	.216	.034
1990	.656	.297	.047	.755	.211	.034
1991	.655	.298	.047	.754	.212	.034
1992	.651	.302	.047	.751	.215	.034
1993	.655	.298	.047	.755	.211	.034
1994	.656	.297	.047	.755	.211	.034
1995	.653	.300	.047	.753	.213	.034
1996	.651	.302	.047	.751	.215	.034
1997	.643	.310	.047	.746	.220	.034
1998	.643	.310	.047	.746	.220	.034
1999	.648	.305	.047	.749	.217	.034
2000	.645	.308	.047	.748	.218	.034
2001	.649	.304	.047	.750	.216	.034
2002	.643	.310	.047	.746	.220	.034

See footnote on next page.

**Table 23—Fraction of age class by year, age class, and housing type<sup>a</sup>**  
(continued)

Year	30-34 age class			35-44 age class		
	Single-family dwelling	Multiple-family dwelling	Mobile home	Single-family dwelling	Multiple-family dwelling	Mobile home
2003	.644	.309	.047	.747	.219	.034
2004	.651	.302	.047	.752	.214	.034
2005	.645	.308	.047	.748	.218	.034
2006	.650	.303	.047	.751	.215	.034
2007	.649	.304	.047	.750	.216	.034
2008	.649	.304	.047	.750	.216	.034
2009	.648	.305	.047	.750	.216	.034
2010	.647	.306	.047	.749	.217	.034
2011	.644	.309	.047	.747	.219	.034
2012	.645	.308	.047	.748	.218	.034
2013	.645	.308	.047	.748	.218	.034
2014	.646	.307	.047	.749	.217	.034
2015	.645	.308	.047	.747	.219	.034
2016	.645	.308	.047	.747	.219	.034
2017	.646	.307	.047	.749	.217	.034
2018	.648	.305	.047	.750	.216	.034
2019	.650	.303	.047	.751	.215	.034
2020	.650	.303	.047	.751	.215	.034
2021	.649	.304	.047	.750	.216	.034
2022	.651	.302	.047	.751	.215	.034
2023	.652	.301	.047	.753	.213	.034
2024	.654	.299	.047	.754	.212	.034
2025	.653	.300	.047	.753	.213	.034
2026	.652	.301	.047	.753	.213	.034
2027	.654	.299	.047	.753	.213	.034
2028	.655	.298	.047	.754	.212	.034
2029	.657	.296	.047	.755	.211	.034
2030	.655	.298	.047	.754	.212	.034
2031	.654	.299	.047	.754	.212	.034
2032	.653	.300	.047	.753	.213	.034
2033	.653	.300	.047	.753	.213	.034
2034	.653	.300	.047	.753	.213	.034
2035	.652	.301	.047	.752	.214	.034
2036	.652	.301	.047	.752	.214	.034
2037	.651	.302	.047	.752	.214	.034
2038	.651	.302	.047	.751	.215	.034
2039	.650	.303	.047	.751	.215	.034
2040	.650	.303	.047	.751	.215	.034

<sup>a</sup> Projected by using estimate of equation (6).

**Table 24—Change in demand for units of housing stock (in thousands), by year<sup>a</sup>**

Year	Single-family dwellings	Multiple-family dwellings	Total private <sup>b</sup>	Mobile homes	Total
1986	1,083	829	1,912	-56	1,856
1987	1,771	865	2,636	125	2,761
1988	1,126	431	1,557	58	1,614
1989	1,171	32	1,203	25	1,228
1990	1,920	587	2,507	128	2,635
1991	1,291	528	1,819	86	1,906
1992	1,140	445	1,584	44	1,629
1993	1,317	79	1,396	30	1,426
1994	1,199	298	1,497	49	1,547
1995	867	209	1,075	26	1,101
1996	919	266	1,185	37	1,222
1997	532	281	814	12	826
1998	1,026	241	1,267	41	1,308
1999	1,276	176	1,452	59	1,511
2000	1,063	442	1,505	64	1,569
2001	1,125	289	1,414	68	1,482
2002	625	384	1,008	41	1,049
2003	1,059	341	1,400	65	1,465
2004	1,296	250	1,546	80	1,625
2005	891	631	1,522	80	1,601
2006	1,107	237	1,344	54	1,399
2007	973	493	1,466	77	1,543
2008	840	360	1,199	60	1,259
2009	818	410	1,227	62	1,289
2010	956	460	1,416	68	1,485
2011	543	373	916	42	958
2012	884	329	1,213	53	1,267
2013	899	416	1,315	63	1,378
2014	907	383	1,290	61	1,351
2015	816	458	1,274	60	1,334
2016	803	340	1,143	48	1,191
2017	822	278	1,100	46	1,146
2018	812	297	1,109	48	1,157
2019	806	284	1,090	47	1,138
2020	739	336	1,075	46	1,121
2021	635	323	958	45	1,002
2022	622	235	857	38	895
2023	629	226	855	40	895
2024	603	236	839	39	878
2025	522	282	804	37	842
2026	488	324	812	43	855
2027	479	192	672	35	707
2028	467	206	673	36	709
2029	455	195	650	36	686
2030	337	275	612	34	646
2031	313	201	514	25	539
2032	335	178	513	25	539
2033	343	179	522	26	548
2034	344	178	522	26	548
2035	339	182	522	26	548

See footnotes on next page.

**Table 24—Change in demand for units of housing stock (in thousands), by year<sup>a</sup> (continued)**

Year	Single-family dwellings	Multiple-family dwellings	Total private <sup>b</sup>	Mobile homes	Total
2036	338	180	518	26	544
2037	341	177	519	26	544
2038	340	181	521	26	547
2039	340	180	520	26	545
2040	342	178	520	26	546

<sup>a</sup>  $I_t - I_{t-1}$ , where  $I$  is defined by equation (2).

<sup>b</sup> Total private refers to sum of single- and multiple-family dwellings.

**Table 25—Housing starts (in thousands) with increasing discard rates, by year<sup>a</sup>**

Year	Single-family dwellings	Multiple-family dwellings	Total private <sup>b</sup>	Mobile homes	Total
1986	1,179	626	1,805	244	2,049
1987	1,852	615	2,467	425	2,892
1988	1,209	181	1,390	358	1,748
1989	1,248	175	1,424	325	1,748
1990	1,695	513	2,208	360	2,569
1991	1,392	473	1,865	320	2,186
1992	887	293	1,181	382	1,563
1993	1,256	15	1,271	282	1,553
1994	1,095	397	1,493	308	1,801
1995	692	351	1,043	406	1,449
1996	764	337	1,101	300	1,401
1997	447	249	696	266	962
1998	1,070	236	1,306	301	1,607
1999	1,425	219	1,643	358	2,001
2000	1,074	537	1,610	373	1,984
2001	1,206	425	1,630	377	2,007
2002	543	447	990	339	1,329
2003	1,174	420	1,594	360	1,954
2004	1,505	422	1,927	372	2,299
2005	1,024	755	1,779	368	2,147
2006	1,132	385	1,517	376	1,893
2007	1,098	664	1,761	395	2,156
2008	1,001	511	1,512	338	1,850
2009	1,004	541	1,545	342	1,887
2010	1,129	608	1,737	354	2,091
2011	753	558	1,311	301	1,612
2012	978	387	1,365	342	1,707
2013	1,000	488	1,489	350	1,839
2014	1,015	471	1,486	348	1,834
2015	931	562	1,493	347	1,840
2016	923	456	1,378	337	1,716
2017	948	403	1,350	338	1,688
2018	958	434	1,392	337	1,730

See footnotes on next page.

**Table 25—Housing starts (in thousands) with increasing discard rates, by year<sup>a</sup> (continued)**

Year	Single-family dwellings	Multiple-family dwellings	Total private <sup>b</sup>	Mobile homes	Total
2019	966	432	1,398	338	1,736
2020	914	487	1,401	338	1,740
2021	831	478	1,309	333	1,642
2022	839	396	1,235	328	1,563
2023	865	397	1,262	330	1,593
2024	852	417	1,269	331	1,601
2025	781	471	1,252	329	1,581
2026	762	518	1,281	334	1,615
2027	766	392	1,158	325	1,483
2028	773	412	1,186	327	1,512
2029	773	408	1,181	326	1,507
2030	663	491	1,154	324	1,478
2031	649	422	1,072	315	1,387
2032	687	404	1,090	314	1,404
2033	706	407	1,113	314	1,426
2034	717	410	1,127	314	1,441
2035	721	419	1,141	314	1,455
2036	730	421	1,151	314	1,465
2037	741	421	1,162	315	1,478
2038	753	433	1,186	315	1,501
2039	767	439	1,205	315	1,521
2040	782	445	1,227	316	1,542

<sup>a</sup> Projection made by using equation (1).

<sup>b</sup> Total private refers to sum of single- and multiple-family dwellings.

**Table 26—Housing starts (in thousands) with constant discard rates, by year<sup>a</sup>**

Year	Single-family dwellings	Multiple-family dwellings	Total private <sup>b</sup>	Mobile homes	Total
2007	1,098	664	1,761	395	2,156
2008	1,001	511	1,512	338	1,850
2009	1,004	541	1,545	342	1,887
2010	1,129	608	1,737	354	2,091
2011	753	558	1,311	301	1,612
2012	972	384	1,356	342	1,698
2013	987	483	1,470	350	1,821
2014	995	463	1,458	348	1,806
2015	904	552	1,456	347	1,802
2016	889	442	1,331	337	1,668
2017	907	386	1,293	338	1,631
2018	910	415	1,325	337	1,662
2019	911	409	1,320	338	1,658
2020	851	462	1,313	338	1,651
2021	758	448	1,206	333	1,539
2022	756	362	1,117	328	1,445

See footnotes on next page.

**Table 26—Housing starts (in thousands) with constant discard rates, by year<sup>a</sup> (continued)**

Year	Single-family dwellings	Multiple-family dwellings	Total private <sup>b</sup>	Mobile homes	Total
2023	770	359	1,129	330	1,460
2024	747	374	1,121	331	1,453
2025	665	424	1,089	329	1,418
2026	636	467	1,102	334	1,436
2027	629	335	964	325	1,289
2028	625	351	976	327	1,302
2029	613	343	955	326	1,281
2030	491	421	913	324	1,237
2031	467	347	814	315	1,129
2032	493	324	817	314	1,131
2033	501	323	824	314	1,137
2034	501	321	822	314	1,136
2035	494	325	819	314	1,134
2036	491	323	814	314	1,128
2037	491	318	809	315	1,124
2038	491	324	816	315	1,131
2039	493	325	819	315	1,134
2040	497	326	823	316	1,139

<sup>a</sup> Projection made by using equation (1).

<sup>b</sup> Total private refers to sum of single- and multiple-family dwellings.







**Montgomery, Claire A. 1989.** Longrun supply and demand of new residential construction in the United States: 1986 to 2040. Res. Pap. PNW-RP-412. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 39 p.

A model of U.S. housing demand and supply was developed that projects housing starts for use in long-term forest planning. Housing demand was shown to respond to the current sale price and the user capital cost of housing and to the size and age composition of the population. Current sale price is determined in the new construction market. Supply of new construction was modeled and was shown to have a supply price elasticity of zero. The choice of housing type was shown to respond to the age of the householder and, in some age classes, to the price of housing services. Two projections of housing starts by housing type from 1987 to 2040 were produced; they differ in the assumed rate of discards from the existing housing stock.

**Keywords:** Housing markets, housing demand, new residential construction.

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